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USSR Report

MACHINE TOOLS AND METALWORKING EQUIPMENT



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INDUSTRY PLANNING AND ECONOMICS

FMS DEVELOPMENT GETS BOOST IN LITHUANIA

Vilnius SOVETSKAYA LITVA in Russian 24 May 84 p 3

[ELTA Article: "Important Tasks For Machinebuilding"]

[Text] The 26th CPSU Congress and subsequent plenums of the CPSU Central Committee outlined a broad program for developing and improving machine building. This branch of the national economy has begun to produce and put into operation so-called flexible manufacturing systems (FMS), that facilitate the organization of highly efficient production with a considerably smaller number of workers, greatly increase labor productivity, and solve the pressing problem of labor resources.

The All-Union Scientific and Technical Conference, which opened in Vilnius on 22 May has been discussing the issues of producing FMS and putting them into operation in machine building. Specialists of union machine building ministries, of scientific institutions and of industrial associations are taking part in the conference.

A.K. Brazauskas, Secretary of the Lithuanian CP Central Committee sent greetings to the conference participants on behalf of the Lithuanian CP Central Committee and the government of the republic.

I.A. Ordinartsev, Deputy Minister of the USSR Ministry of the Machine Tool and Tool Building Industry, gave a report at the conference on the tasks of the collectives of the industry's enterprises and organizations for putting into practice the program mapped out by the party and government in the area of producing FMS and putting them into operation.

It was noted at the conference that industrial enterprises and scientific institutions, and the industry's design organizations are performing considerable work to improve industrial efficiency on the basis of FMS. A number of flexible centers and lines and fabricating sectors have already been set up and introduced. At several firms, computer-controlled automatic systems that include a group of machine tools with numerical program control, an automated transport system and a system of instrument-supported supply to the machine tools, and monitoring devices for quality control of components

have brought about virtually complete automation of the work connected with mechanical fabrication, and have significantly increased the machine shift coefficient. These systems will serve as the prerequisite for creating an "unmanned technology" and for the output of high-quality products with minimum labor costs.

Yu.L. Rusenko, Deputy Chairman of the LiSSR Council of Ministers, and other executive personnel of the republic's national economy have taken part in the work of the conference.

The conference will last for three days.

12697

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INDUSTRY PLANNING AND ECONOMICS

CEMA MEETING ON COOPERATION IN R & D, PRODUCTION

Moscow EKONOMICHESKAYA GAZETA in Russian No 16, Apr 84 p 20

[Editorial: "Cooperation of Machinebuilders"]

[Text] TASS--The 91st Meeting of the CEMA Standing Commission on Cooperation in the Area of Machine Building took place. Delegates of CEMA member-countries as well as Yugoslavia participated in it.

The commission discussed tasks resulting from the resolutions of the 37th Meeting Session of CEMA and its executive committee and adopted decisions on realization of the "Basic Directions of Expanding and Improving Cooperation of CEMA Member-Countries for the Economic and Efficient Use of Fuel and Energy and Raw Material Resources, Including Secondary" and "Comprehensive Measures of Cooperation for Improvement of the Supplying of the Population of CEMA Member-Countries with Food Products".

The commission approved proposals for production specialization of truck diesel engines, their assemblies and parts for 1986-1990. The progress of realizing the general agreement on multilateral cooperation in the development and organization of specialized and cooperative production of industrial robots was examined. The status of work for developing machine tools with numerical program control based on the joint coordination plan approved by the ispolkom was analyzed and appropriate measures taken.

Approved and recommended for signature were draft treaties on production specialization and cooperation of means of technical equipment of shipbuilding and manufacturing equipment for production of assembly components for large-panel housing construction, units and assemblies of oil and gas drilling equipment and other equipment.

Reports were approved on work done by the commission in 1983 and on its future activities, as well as on the progress and results of work on scientific and technical cooperation, the effectiveness of this work and assimilation in production of newly developed machinery, equipment and instruments conforming to the current technical level.

Other issues of economic and scientific and technical cooperation were also examined.

The meeting of the commission took place in an atmosphere of friendship and mutual understanding.

12567

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INDUSTRY PLANNING AND ECONOMICS

ADVANCED EQUIPMENT OF UKRANIAN TRACTOR PLANTS VIEWED

Kiev RABOCHAYA GAZETA in Russian 4 May 84 p 2

[Article by RABOCHAYA GAZETA correspondent Yu. Kovalenko, Kharkov: "Give the Robot an Owner"]

[Text] Kharkov Oblast is the traditionally established tractor machine building center in our republic. Besides the legendary KhTZ (Kharkov Tractor Plant), also located here are major plants, planning and scientific research institutes and design buro's of the industry, on whose work the successful fulfillment of the Food Program largely depends.

Today tractor building, so to speak, is experiencing a scheduled technical revolution. Besides the customary automatic and mechanized lines, ever increasing numbers of units equipped with microcomputers are appearing in enterprises, sections and shops. Cybernetics in its material embodiment is literally breaking into stabilized production processes and in so doing is generating a whole series of new problems for the sector.

It is not worthwhile, obviously, to blame anyone for wanting to show something to good effect. Therefore, when the subject turns to automation and the Kharkovshchina tractor builders name the Chuguyev Fuel Equipment Plant--it is understandable. The level of mechanization here is 82 percent. Complete series-production robot systems are operating in the machine shops, almost totally eliminating manual labor.

However, machine tool manipulators can also be encountered at other plants of the sector. They have taken root. Lathe, milling machine and drill operators affectionately call them smart machines.

But in the overall structure of tractor building, the portion of press-forging and die-forging production is great. Outwardly these shops also look immense. In one or two blows, the powerful hammers give the pieces of metal the contours of the future parts.

You glance, for example, at the work of I. M. Khar'kov and are filled with admiration. The precise alignment movements of the master, the chunks of white-hot metal, the myriad of sparks after each blow of the many-ton hammer--no, it is not without reason that the blacksmith trade has been romanticized by the people since olden times.

You go closer and stand beside Ivan Mikhaylovich for a minute, and another.... The flame from the furnace is scorching. There is oppressive heat and a roar. But each blank which he handles with such ease is no bit of fluff: it weighs about 20 kilograms! During a shift he picks up 100 tons of them. It is not easy, not simple....

"Here, I'll explain," V. Zharov, chief KhTZ process engineer, concurs with me. "The machine tool undoubtedly needs a robot. But for forging production and for the foundries a rapidly readjustable robot-manipulator is vitally necessary. Even today we sometimes cannot attract workers to the presses, hammers and the cupolas even with high earnings. What will happen tomorrow? That's the problem! Where do you get these very robots? Do you know where? I didn't think so. I don't know either. No one knows."

I. M. Khar'kov's work place is typical for forging production at tractor machine building enterprises. It is the same as that of hundreds of workers maintaining forging and pressing equipment not only at the KhTZ, but also at the neighboring Serp i Molot, the Lozovskiy Forging and Machinery and other enterprises. Perhaps that is why, when the subject of the robotization of namely these sections, engineers and specialists expressed not simply concern or interest, but genuine hurt. A. Shaternikov, in charge of the robotization buro at the KhTZ, in a fit of temper thumped the table with a catalog.

"Here, look at this. Of the dozens of models offered, only one is suitable for blacksmiths--the Krasnodar SM-40Ts. We set our hopes on it and, like a miracle, we received it--and cried. The robot was not able to move even a 40-kilogram blank, even though according to its specifications it is supposed to handle more weight."

"It's a waste of time to present a claim to the manufacturer," the specialist continued. "You won't wait for the repairmen anyway. We decided to improve the hydraulic system ourselves. We put our minds to it--it turned out that the control unit is no good. But maybe, it only seems that way? It's entirely possible. There are practically no specialists on robot technology at the plant. True, there are appropriate subdivisions in our ministry. But we haven't laid eyes on electronics technicians, programmers or repairmen of such equipment from there. We have been fighting with it ourselves for a year. However, it's no use."

Indeed, what benefit can there be if robotization at the tractor machine building plants is so far being done by the formula: the shoemaker bakes the pies. That is, it is being done essentially by people having nothing to do with, either by education or work experience.

It would be understandable if the trying experiences of the tractor builders were limited to miscalculations in construction of one or two series-produced robots, but quite often something has to be changed, finished or improved. Every manipulator has to be worked on. For example, an automated unit was delivered to the Lozovskiy Forging and Machinery Plant from Chelyabinsk. They didn't expect much from it: feed and remove blanks--this was stipulated by the specifications. They neglected to do it--either one way or the other. They toiled and toiled--and all for naught. Much money was wasted. They found out at the same KhTZ that the Minsk Kontur-002 robot can paint cabs. They moved it out and delivered it to the plant, but it only applies primer. There are many similar adjustments and disparities with the specifications accompanying the robots.

In general, there is much work being done on automation of labor-intensive processes at the KhTZ. Devices for loading many of the forging furnaces have been designed and manufactured by their own people. A line of metal-removal machine tools is operating in one of the machine shops. It is serviced by "Brigs" made by the tractor builders themselves. The welding facility is equipped with appropriate mechanical assistants. Automations service powerful presses in the cab-accessory section of the plant.

However, no matter how convincing the qualitative indicators may be, they are not the point. The most ponderable argument in favor of automation is the steady growth of the enterprise's basic indicators. This is the principle. But so far there is no appreciable return from introduction of even the most modern robot systems at the KhTZ or the other Kharkov tractor machine building plants. Why?

The cost of robots is quite high and if they do not have an effect on the final indicators by freeing human hands, the costs for maintaining the mechanical "workers" place a heavy burden on fixed capital. Here, neither one or two automated lines, nor a section equipped completely equipped with manipulators, nor a robotized shop will help. For the rhythm set by robot technology must be synchronized with the production pulse of all subdivision of an enterprise.

It is possible to achieve such a synchronization only with a scrupulous analysis of the technical equipment of each work place and the real potentialities of an individual machine tool, lines and shops. Only then can one bring to light the shortcomings of individual manufacturing processes that are not evident as well as the disharmony in interactions of the links and subdivisions of the entire facility. But such an analysis, as a rule, is only within the powers of a major scientific research and design institute. Such a task is not always within the power of plant specialists, busy with the daily needs of the production line.

At the KhTZ the situation is aggravated further by the fact that a radical modernization is being completed, the plan of which was approved 8 years ago. Then neither the planners nor the tractor builders even mentioned robotization. Now, when the capital investments allocated for the modernization have been acquired and the set-up of the plant according the

general plan has essentially been equipped, considerable efforts are needed in order to squeeze the robot into the operating flow and to insert new technical ideas into the Procrustean bed of operating production. But this is necessary, for there is much outdated technology in tractor building.

Such a situation exists at more than one of the sector's enterprises, even at the most modern of them--the tractor engine plant. Representative in this sense is the fate of the section for cleaning crankcase blocks and a number of other parts. Under the plan they were cleaned by workers equipped...with hoses. What kind of working conditions are these? Moreover, you can't look into every opening. There is no guarantee whatsoever that the assembly is suitable after such a cleaning.

The plant's bureau of robot technology worked on developing an automated washer. Now the transfer arm places the crankcase blocks on an enclosed vibrator, where chips, sand and metal fragments are removed. A special solution is fed under high pressure, washing out all the openings and inner cavities. It would appear that the problem has been solved.

But now that the component or assembly has passed through the cleaning cycle, it has to be transferred to an adjacent line. An overhead-track hoist moves and a worker follows along with it. You wouldn't call it hard work--it is not necessary to strain your muscles. But there is not much joy either--the classification is appropriate: manual machine labor. These overhead-track hoist operators are simply eyesore against the background of automated lines.

True, this operation also has come into the field of view of the newly established bureau of robot technology. It has been decided to interlink all of the lines by using transfer arms equipped with memories. But it is not so simple to master this task. There are not enough specialists.

"The order for establishing a bureau of robot technology at the sector's plants," says its chief Yu. Kononeko, "was issued, but a number of issues had not been resolved. They say, try to find internal resources. It takes two or three designers. But what about electronics engineers and cybernetics? Such specialists are not provided for by our personnel schedule."

Is it possible to expect any real return from such bureaus? Of course not. But even in those instances, when by various contrivances with personnel at the plants it is possible to establish a collective able to design the necessary robot-manipulator and to translate the drawings into metal, it is not so simple. At that same tractor engine plant the capacity of the mechanization and automation shop is almost less than half that required. This is yet another barrier on the path of robotization.

In short, the situation that has unfolded with the introduction of robot technology at some of the major Kharkov enterprises corresponds to the saying: One pulls one way and the other pulls the other way. Each plant is solving the problem in its own way, as each can. The enterprises plainly do not have enough manpower. But above all, there is no unified technical policy in this matter.

It is obvious that, instead of establishing weak robotization buros and low-capacity sections for production of manipulators at each enterprise, it is necessary to see to it that these forces are concentrated. Why not set up a powerful firm right in Kharkov, whose duties would include the specific responsibility of robotization of tractor machine building in the region? With its scientific research department, it would be able to analyze operating plants and recommend general robotization plans of each taken separately. With a design buro (DB), it would be able to develop high-quality plans of individual robots and robot systems. With a production subdivision, it would be able to put the designing plans to metal. Also, there would be no need either to build new plants or to set up new scientific research institutes (SRI) or DB's. The base for resolving an entire range of tasks exists. All that is needed is an agency, a special center, which would combine and direct into a single, scientifically sound channel the efforts of the SRI's, DB's and enterprises of tractor machine building in the republic. The KhTZ, let's say, probably could manufacture forging robots both for itself and for the neighboring Serp i Molot. The tractor engine plant could organize production of transfer arms equipped with memories and supply them to all related enterprises. More briefly, specialization under a unified technical policy is needed on a sector-wide scale. Only then will robots not be homeless.

12567

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INDUSTRY PLANNING AND ECONOMICS

EQUIPMENT OF NEW ODESSA MACHINE TOOL PLANT VIEWED

Moscow IZVESTIYA in Russian 15 Apr 84 p 2

[Article by IZVESTIYA correspondent F. Chernetskiy (Odessa): "The Renovation Continues"]

[Text] They recently returned from a business trip to the GDR and now in the evenings, when everyday, current worries disappear, stay late in the director's office. The trip, in their opinion, was productive. They visited many related enterprises, shared their experience and derived much themselves. The hospitable hosts acquainted them with their innovations and provided drawings, prospectuses and diagrams. While before this there were trips to Czechoslovakia and Hungary. And now it is necessary to examine everything in detail, to select from everything seen and heard what is most valuable and to formulate their own program.

The idea arose back at the time when the firm conviction of the need for the complete renovation of the enterprise had ripened. It, the renovation, strictly speaking, was also the first stage on the road to the distant goal, which the managers of the enterprise brought forth, without advertising it extensively. K. Manenkov, general director of the machine tool building association, chief process engineer I. Litvakov and chief electrical engineer Ye. Yershov came to the conclusion that if one is to undertake in earnest the solution of the problem of the intensification of production, first of all it is necessary at the same site, where the enterprise is located, to build in essence a new plant. A modern plant.

But the production plans increased from year to year. In the Ministry of the Machine Tool and Tool Building Industry they explained the situation this way: "The Odessa association is the only enterprise in the country, which produces diamond boring and radial drilling machines. There is no backup plant. The needs for this type of equipment are increasing, the plans are also increasing accordingly." Whereas on the eve of renovation, in 1978, the association produced output worth 22 million rubles, in approximately 15 years the production volume should reach the level of 100-120 million rubles.

A mockup drawing: a bird's-eye view of the enterprise, hangs on the wall in the office of the director. There are three colors on the drawing: blue, orange and yellow. The blue was distributed extensively, and this means that

the renovation of the plant is being completed. Only sprinkles of orange--what is still being reconstructed--remained. With each year more and more yellow is appearing: a new residential settlement is being built up.

Let us state frankly that the renovation did not come easily. At first the ministry singled out a contractor. A year passed. They succeeded in demolishing something, but did not build anything new. Everything got bogged down in endless disputes and mutual complaints. Somehow gradually, unnoticeably all the worries were shifted onto the shoulders of the association itself: now the builders do not have manpower, now they have difficulties with the machinery, now some "burning" projects appear, and people are urgently transferred there. The builders strove to carry out the work as was more convenient for them. But what was convenient for the builders, brought the association to its knees. For the renovation was being carried out under the conditions of an operating enterprise, no one had free it from the plans. In short, they did not work well together with the contractor. The question of setting up its own construction and installation administration had to be posed to the ministry. In essence they carried out the renovation themselves, by the plant collective.

But the rate of production of machine tools did not decline, on the contrary, it increased: whereas in 1978, the year of the start of renovation, the association produced output worth 22 million rubles, the plan for this year, when reconstruction is still continuing, envisages a twofold greater production volume. It is also no less important that during this period the range of items was updated significantly. New models of machine tools were put into production, which it was impossible to do under the former conditions. And, strictly speaking, these are no longer machine tools in the usually understanding--they are called now a module, now a complex, now a processing center.

New equipment, if one speaks about not its custom, but flow-line production, also requires a different approach to the organization of the work. And now, after the renovation, when the shops have been furnished with modern equipment, of which about 25 million rubles was purchased, the time has come to engage in the setting up of an enterprise of a fundamentally new type.

Such a decision is explained by the following considerations. The association is experiencing a shortage of manpower resources, and one must not count on their replenishment. Hence the entire increase of the production volumes--to 120 million rubles--must be provided in essence with the same number of workers. This is the first thing. Second: the enlargement of the list of items and products, which are complicated in their design characteristics, has also been noted now, while in the future will appear on an even larger scale. And the managers of the association see the most effective, advisable way out in the reconstruction of the enterprise on the basis of the principles of flexible automated production.

The director takes out of his desk and unfolds a diagram of the future production section-module. Here machine tools like the "processing center" have been set up in two rows. Between them there is a network of transport arteries. They are joined in the automated warehouse, from which blanks are delivered and to which finished parts are sent. This entire system--the machine tools, the transport arteries and the automated warehouse--are put into operation and controlled by a computer. Such a section-module, in addition to the fact that it

is controlled by one operator, also has the advantage which is defined by the concept "versatility." The module makes it possible without protracted pauses to change the products list, by being rearranged quickly, makes it possible to curtail in good time the output of obsolete products and to change over mobily to fundamentally new items, which have higher consumer qualities.

This is what goal the managers of the association set for themselves. The task, of course, is difficult. But the forces, which have been gathered here, are significant: 700 specialists work in the specialized design bureau and up to 300 workers work in the technological bureau.

Indeed, at first everything seemed simpler. They planned as follows: to purchase processing centers in Ivanovo, and then to appeal to some leading scientific research institute, to the same State Planning, Technological and Experimental Institute for the Organization of the Machine Tool and Tool Building Industry, to develop on their basis a versatile automated section-module, and then, by relying on it, to rearrange everything on its own. Each of the institutes, to which they turned, assumed only individual, local tasks. Some dealt only with control problems, others--software, still others--technology. But who will assume the coordinating functions? And the association, as in case of renovation, had to assume the role of both the general designer and the general contractor. Its own scientific research subdivision was set up. Its workers, just as the managers of the enterprise, are gathering know-how by grains and are adapting it to the conditions of their own works. Now during the trip to the GDR they picked up much, especially at the (Rawema) firm. This is an integrated center, which deals with versatile automated plants. The firm designs, develops, carries out contract supervision, sets up and teaches. The association has established close contacts with (Rawema).

"We believe," chief process engineer I. Litvakov shares his thoughts, "that we are capable of the task which we have assumed, for the association has the necessary intellectual potential. But what are enterprises, which do not have such powerful design and technological bureaus, to do? It is possible to invest vast assets and not to obtain a return."

In the evenings they sit for a long time in the director's office. As then, during the initial period of renovation, they have a large number of worries and urgent matters. And, strictly speaking, the renovation is continuing, it is merely directed toward a higher goal--to bring the association to the leading level of scientific and technical progress and, by relying on the gained experience, to organize there the production of versatile automated systems for the national economy of the country.

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CSO: 1823/259

METAL-CUTTING AND METAL-FORMING MACHINE TOOLS

INTEGRATION PROBLEMS FOR BELORUSSIAN MACHINE TOOL BUILDERS

Minsk PROMYSHLENNOST' BELORUSSII in Russian No 10, Oct 83 pp 36-39

[Article by G. Naumovich, chief engineer at the Minsk Broaching and Shearing Machine Tool Production Association imeni S. M. Kirov, and candidate of technical sciences Ye. Markin, head of the machine tool research laboratory; photos by A. Akhremchik; under the heading "Alliance of Science and Production," sub-headed "To (Produce) the Best Machine Tools in the World": "Modernization Dynamics"]

[Text] Ten years ago, the Minsk Machine Tool Manufacturing Plant imeni S. M. Kirov switched over fully to producing new broaching machines and withdrew obsolete models from production. In the end, this was a result of creative efforts by the collectives of the enterprise and the special broacher design bureau (SKB PS). At approximately the same time, the editorial staff of PROMYSHLENNOST' BELORUSSII held a round-table discussion on improving the effectiveness of new equipment. Representatives of the machine tool plant imeni S. M. Kirov and the SKB PS participated in that discussion. It was then that they first revealed they were developing new high-speed broachers. These machine tools now exist, and the enterprise is mastering their series production.

The development of new equipment is a complex task. Life convinces us that its successful resolution is possible only on the basis of a close interaction between its developers and specialists and scientists from the specialized scientific research institutes. However, before we can speak of our common successes in developing a new range of machine tools and their advantages, we should dwell on several problems in machinebuilding.

Let us begin with a concrete fact: machinebuilding currently uses 56 percent of the available metalworking machine tools. Over the past 15 years, the number of machine tools and forge-press machines in this branch has increased 2.4-fold, while it has increased 2.7-fold in other branches. Unfortunately, this growth in production volume has not been accompanied by improvement in product quality. To the contrary, this problem has become more difficult. Inadequately high equipment reliability and the lack of spare parts are forcing consumers to maintain huge numbers of machine tools. We should note that, during this same period, the number of machine tools and forge-press machines in the USA decreased

1/7 the former number (thanks to improvement in their production structure). The reference is to "processing-center" machine tools of higher unit power and equipped with manipulators. To complete the picture, let us add that in our country 2.7 percent of the machine-tool fleet is updated annually; in the U.S. -- 5.5 percent, in the FRG -- 8-9 percent.

In accordance with the tasks set machinebuilders by the 26th Party Congress, we have finally determined the directions for designing fourth-generation broachers. The primary among these is to ensure a 1.5- to two-fold increase in productivity, a 20-30 percent improvement in machining precision, a reduction in machine tool weight of 200 kg or more, improved reliability and durability, a higher level of standardization and more convenient servicing.

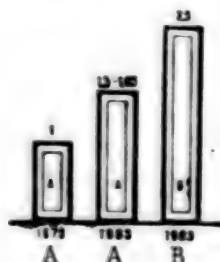
Of course, our plans would not be feasible were we not to improve production itself. Specific assignments concerning the level of automation of special machine tools have been communicated to all SKB PS departments and plant production subdivisions. Technological processes are being improved and new methods of metalworking introduced. The goal is the same, to improve product quality and labor productivity. In preparing production to release a range of broachers in the 1970's, the plant introduced 13 mechanized machining flow lines, strain-hardening technology and rotary cutting. During the first two years of the 11th Five-Year Plan, 80 percent of all capital investment has been spent on retooling the plant, resulting in the attainment of a 3.8 million ruble increment in production capacity. We introduced 386 measures, permitting a reduction of 250,500 norm-hours in machine tool manufacturing labor intensiveness. Labor productivity rose 7.6 percent, given a planned 3.5 percent. The entire increment in production was obtained through improvement in this indicator. By the end of the 11th Five-Year Plan, the level of basic and auxiliary production automation and mechanization will have reached 85 and 69 percent, respectively.

The comprehensive program for raising the technical level of equipment being produced includes experimental design and research work on mastering automation equipment, NPC machine tools and modules. Moreover, as was already noted, it is very important to improve the machine tool structure. Analysis shows that it is appropriate to change the parametric series as compared with the 1970's series. Machine tools in the new series currently correspond to the parametric series with a coefficient of 1.6, meaning that they develop tractive forces of 40, 63, 100, 160, 250, 400, 630, 800 and 1,000 kilo-Newtons. This sequence of tractive forces provides a number of technical-economic advantages. In particular, the customer has an opportunity to choose a model which more closely meets his requirements in terms of tractive force, ensuring a savings in energy and metal.

Broacher models are available in a wider range of working travel lengths. Based on experience in operating them in the national economy, we were convinced that it is appropriate to produce a modification with longer working travel. As a result, the equipment technical use coefficient has been increased. Two to four working-travel length modifications are anticipated for machine tools with tractive force of 100 and 250 kN. A machine with greater working travel length replaces two machines with a shorter length; production space, metal and assembly components are saved and operator manpower is freed for other work.

The research done has also yielded other interesting results. For example, if the cost of broacher loading devices does not exceed 50-70 percent of the cost of the base model, the use of these automata is economically justified only on the condition that they are not reset more often than once a quarter. Otherwise, it is more efficient to use semiautomatic machines.

Growth in Broacher Productivity



Key:

- A. Automatic and semiautomatic broachers
- B. High-speed automatic broachers

An immediate concomitant to these problems is the question of how to evaluate the technical level of a machine tool. Its power (defined as the force exerted and the speed of the tool on the blank) and the size of the blank are very important characteristics of technical level. Let us note that each depends on the availability of assembly components for the machine and on their technical level.

We also need to note here that our suppliers are not up to the demands being made, with regard to electronics, for example. Electrical equipment and electronics industry and instrument making are thus far not fully meeting the needs of machinebuilding, requiring high expenditures on the importation of many types of machine tools and forge-press machinery. The substantial shortcomings of our programming equipment include insufficient functions, poor integration, poor reliability and large size. Therefore, nearly half the multiple-tool numerical programmed-control machine tools of the "processing center" type are equipped with imported assembly components.

And one other indicator. Many specialists have now concluded that the layout of a machine tool is a technical characteristic of equal importance to, say, power, speed, and so on. Unfortunately, a unified indicator has not yet been chosen for this. Quite obviously, it, like other comparative characteristics for evaluating technical level, can be approached only through physical testing.

These questions acquire particular importance when a qualitative leap is made in the development of new equipment. For use, the development of this new series of high-speed broachers was such an instance. The plant imeni S. M. Kirov will be producing broachers for internal and external broaching, with working travel speeds of up to 25 m/min, and vertical broachers for internal broaching, with working travel speeds of up to 40 m/min.

The introduction of high-speed broachers permits a 2.5-fold increase in equipment productivity, on average, an improvement in broach strength due to the possibility of choosing optimum cutting speeds, and improvement in the quality of the surfaces being machined.

When developing the high-speed broachers, the problem of a durable tool with higher accuracy reserve was critical. The plant and the SKB PS have been working on this, and promising results have already been obtained.

Development of the new series required further development of work in the area of automating broachers. In the 10th Five-Year Plan, these problems were solved by providing them with automatic attachments for loading and unloading the parts being worked. However, it was not possible to automate in this way the loading of parts of complex shape (cantilevers and connecting rods, for example). Moreover, if the part being machined is changed, it is hard to adjust such attachments, and when the shape of the part is changed, readjustment is impossible.

In view of all this, the SKB PS has begun developing automatic manipulators which permit moving the part during raising and lowering, loading and unloading, without contacting the guide surfaces. The sole point of adjustment is the clamp which grips the part for moving. It becomes possible to transport parts of practically any configuration. Type MPM2 manipulators (floor model) are in the form of two arms, with independent vertical movement of each arm and rotation of the manipulator around the vertical axis. Vertical broachers with tractive force of 100 and 250 kN and travel of 1,250 mm can be equipped with them.

The overhead-model MPM4 manipulators have two independent arms and easy access to the working zone. Vertical broachers are equipped with them. The MPM15 manipulators have a collector-transporter with a sector for vertical blank feed to the broacher table level; they have the advantages of small size and ease of operation. Vertical external and internal broachers with low tractive force (40 kN) are equipped with these manipulators. Labor productivity is increased four-fold. The MPM14 manipulator is designed for use on continuous broachers. Use of manipulators of this type on seven continuous-operation machines for processing connecting rods and cylinder heads yielded an annual economic impact totalling 430 thousand rubles.

Finally, the MPM1 manipulator, designed for "processing-center" internal broaching machines with tool magazines. Its use with the 4MP637 enables us to automate the broaching of apertures in a broad products list of parts such as flanges, pistons, rings, and so on. Labor productivity is increased approximately two-fold, especially on heavy parts weighing up to 40 kg.

Machine tools with flexible readjustment have, to a certain extent, solved the problem of surplus capacity. The fact is that, at a number of enterprises, expensive machine tools with numerical programmed control have a shift index of 1.1 to 1.3. EKO magazine points out that NPC machine tools, weighing upwards of 20 tons and costing 600,000 rubles, are working parts 100-200 mm long and wide. This occurs because there is no reliable, precise, small equipment, including processing centers.

Thus, machine tools with high unit power must be equipped with flexible readjustment systems, and small machines must have corresponding precision, reliability and automation. This is what we are working towards in developing the new models.

I should also like to touch on another question the developers of new machine tools unavoidably encounter. The reference is to unifying measurements and the

submission of data obtained. This unity must be achieved if we want to increase export deliveries of machine tools. The essence of the work facing us reduces to the fact that any measurement lacking a statistical description is ineffective. Consequently, tolerances are inadequate in evaluating quality control. Enterprises and organizations must therefore fundamentally review the role of the metrological services.

We noted in the "roundtable" discussion (nearly 10 years ago): "The republic metrological service must ensure not only the monitoring of measuring equipment condition, but must also become an initiator in the development of models of this equipment. We cannot count on improved new equipment efficiency and quality without the resolution of these questions." Life has confirmed the correctness of this position, but we have not yet seen fundamental advancements, unfortunately.

The use of fourth-generation broaching machines will ensure an average 1.6-fold improvement in productivity, the calculated freeing of about 300 machine tool operators a year for other work, and the saving of about 2,000 square meters of production space. The economic impact of introducing this series into the national economy will be 33.5 million rubles.

Of course, machine tool makers and the SKB PS collective are well aware that what has been achieved is by no means the limit. We will continue improving the equipment we produce, so as to achieve a situation in which it will yield a tangible national economic impact.



Vertical Broacher Equipped With MPM2 Manipulators: The use of MPM-2 manipulators when working heavy parts and complexly shaped parts yields an economic impact of 25,000 rubles per year per machine.



Vertical Broacher With An MPM4 Overhead Manipulator: The working zone remains free, making it easier to service. Economic impact -- 19,000 rubles per year per machine.

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ELECTRICAL DISCHARGE, AIR BLAST MACHINING SYSTEM

Kiev *TEKHNLOGIYA I ORGANIZATSIYA PROIZVODSTVA* in Russian No 2, Feb 84
pp 34-37

[Article by Yu. A. Moshenskiy, candidate of technical sciences, A. M. Petrichenko, doctor of technical sciences and T. I. Alekseyeva, engineer, "Air-Electric Arc Machining of Iron Castings"]

[Text] In the production of iron castings considerable labor and means are required to machine castings -- cutting off risers, eliminating bleeders, ribs etc. These labor-intensive operations are done by milling and cut-off machine tools, pneumatic chisels and manual pneumatic and electrical grinding machines.

The more efficient method for machining castings is the use of the powerful electric arc and jets of compressed air to remove smelted metal from the melting zone. A forge chisel was developed to implement this method that provides a stable process at a current of 2500 to 4000 amperes of a low-voltage arc (Fig. 1).

The forge chisel is made basically of chromium bronze. All of its metal non-detachable transition components are connected by high temperature brazing. Air under pressure of 5 to 6 kg-force/cm² is passed through the forge chisel channel as a result of which, at an arc current of 4000 amperes, the temperature of the metal parts does not exceed 50°C, and of the chisel handle -- 20 to 25°C since it is insulated with fiber glass.

To implement the process at a current higher than 1500 amperes, it is preferable to use as electrodes 20 x 25 mm cross section plates, 300 to 400 mm long made of graphitized lining plates or other graphitized materials.

In manufacturing the air-arc forge chisel device, reduced voltage welding as well as electric furnace transformers of the required capacity are used.

It is good practice to establish the section for air-electric arc machining of iron castings near where the castings are removed from the molds or in the thermal trimming shops. Its area is 80m². The following equipment is located on the section (Fig. 2): device 2, high voltage power cabinet 1 with automatic protection, low voltage distribution cabinet, forge chisel 9 with the

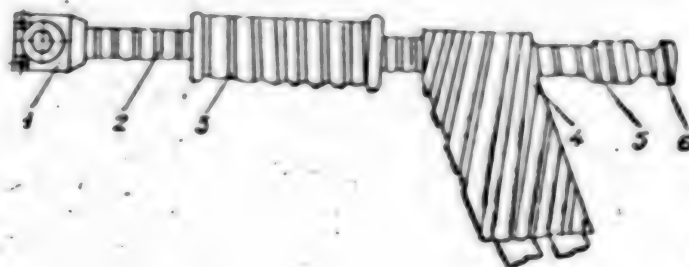


Fig. 1. General view of the forge chisel: 1 -- head; 2 -- current-air feed line; 3 -- handle; 4 -- current feed clamp; 5 -- connecting nut; 6 -- air sleeve.

welding conductor and a rubber cloth air sleeve 1, stand 8 to hold the chisel when it is not in use, an air main pipe with valve and connecting pipe 10, cabinet 7 to store electrodes, work bench 6, contact plate 4, bus 11 from the secondary winding of the transformer to the contact plate, ventilation panels 3, and metal container for electrode cinders.

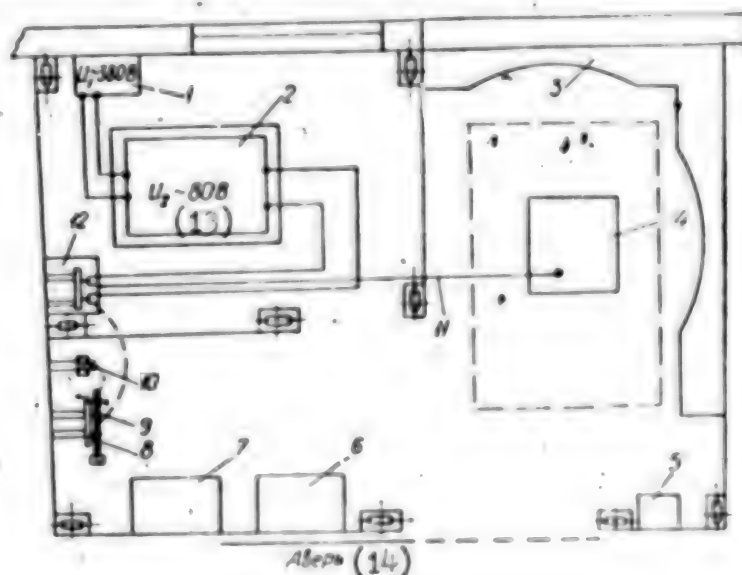


Fig. 2. Arrangement of section for air-electrical arc machining of iron castings: 13 -- 80 volts; 14 -- Door.

The basic unit of the section is device 2 that has one, two or three welding transformers with a total power of not less than 240 to 300 kw. For convenience of operation, the transformers are up on a metal shelf 400 to 500 mm high. When two or more transformers are operated in parallel, the secondary windings of the transformers are connected to the low voltage distribution cabinet 12 of the secondary voltage which feeds the working circuit (connecting chisel 9 to contact plate 4).

The low voltage distribution cabinet includes a textolite plate 30 mm thick, copper terminal bolts 30 mm in diameter, copper bus connectors with a cross section of 10 x 80 mm and a metal cabinet on legs for wiring the indicated components.

It should be noted that when one TDFZh-2002-U3 transformer is used, the distribution cabinet becomes unnecessary because it has fairly rigid bus terminals with a large surface.

The chisel is connected by a welding conductor 14 to 15 m long with one secondary winding transformer terminal. The terminal of the welding wire, connected to the transformer terminal, has a large contact surface corresponding to the surface of the secondary transformer winding terminal. The bus conductor, connected from the secondary transformer winding to the contact plate, may be made of separate parts which are lapped and joined with bolts. The cross section of the copper bus conductor is 10 x 100 mm. It is placed in a covered channel made of a channel bar and is covered on top by a steel sheet.

Steel contact plate 4, 60 to 80 mm thick and an area of 2m^2 is placed together with hardware in the central part of the section. After cementing, it protrudes along the entire perimeter above floor level. The floor is cemented around the contact plate at the work position of the operator (shown by a broken line in Fig. 2.)

A solid metal enclosure 2 m high is installed around the device to protect the air-arc forge chisel from sparks and sprays of molten metal and slag. The entire section has a similar enclosure.

The following current (at arc voltages of 30 to 50 volts and air pressures of 4 to 7 kg-force/ m^2) are recommended for various technological processes on iron castings), in amperes: cutting off risers up to 200 and 200 to 400 mm -- 2000 to 2500 and 2500 to 3800 respectively; shaving bleeders and molding sand pickups -- 1600 to 2200; eliminating slanting -- 1300 to 2000.

The developed technology was introduced into production. An investigation of the structure and hardness of gray, high-strength and malleable cast iron indicated that a thin hardened layer forms directly at the surface of the cut. In the finishing treatment of the surface by the air-electric arc method with a high movement speed of the arc and a thin layer of the metal removed (1 to 3 mm), the layer of the most hardened structures does not exceed 0.3 mm. Beyond that layer in the zone of the thermal effect, there is a softer layer with structures of incomplete decomposition austenite (troostite and sorbite). The greater hardness when observing optimal modes does not exceed 1.5 mm

(depth of cut from the surface). Therefore, when it is necessary to machine the surfaces hardened by the air-electric arc method, it is necessary to use emery for a depth of 1.5 to 2 mm. If special machining is not required, the treated surface can be leveled slightly with emery or left without additional shaving because it has an attractive commercial appearance directly after the air-electric arc planing.

This method may also be used to shave steels, nonferrous metals and their alloys; however, the lower level air pressure fed for technological blasting must be raised to 5-6 kg-force/mm².

In introducing the air-electric arc metal shaving by a powerful arc, labor productivity is increased 5 to 10 times as compared to traditional methods of machining. The important advantages of this method are its relative simplicity and low capital expenditures to introduce it.

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FLOOR PLAN, COMPONENTS OF SOVIET FMS VIEWED

Kiev TEKHNLOGIYA I ORGANIZATSIYA PROIZVODSTVA in Russian No 1, Jan 84 pp 6-7

[Article by engineer A. M. Voychinskiy, under the heading "Production Organization and Management": "Improving FMS Standard Structures Management in the Machine Shop"]

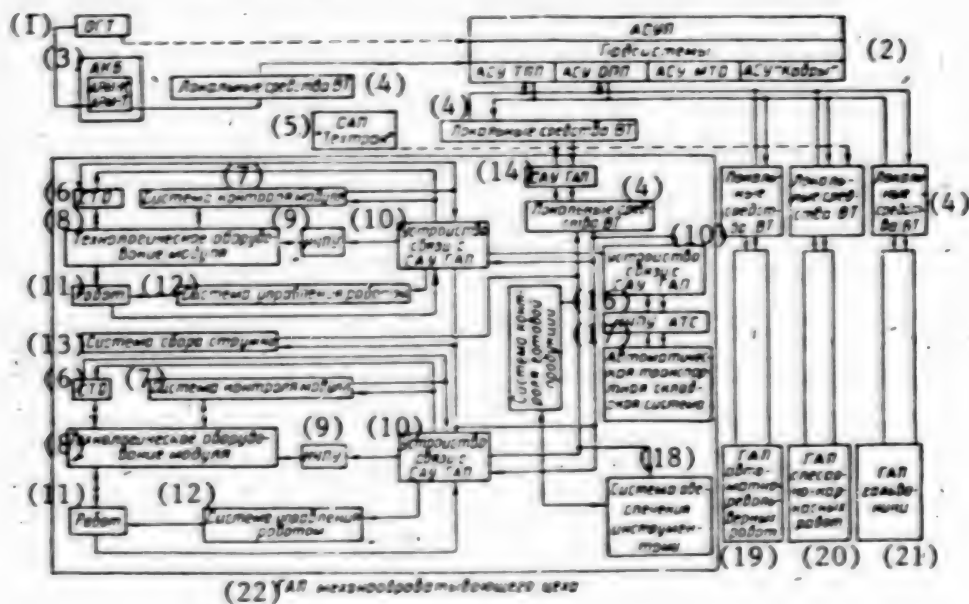
[Text] The introduction of computer equipment (VT) into machinebuilding and the improved reliability and lower cost of machine tools with numerical programmed control has created an opportunity for the comprehensive automation of small-series production. The "Gnom," "Mars," "Kontur," RF-201, RF-202, RF-204M and other robots have been designed and are being series produced and centrally supplied for this purpose in radio-engineering industry.

The planning of flexible automated production (GAP [FMS: flexible manufacturing system]) at branch enterprises generally begins with the development and building of automated lines, sectors and shops. An efficient variant for organizing all production in the shop, as the smallest but most independent plant subdivision, is determined at this stage: unified VT is selected, unified materials-transport flows are calculated. In this regard, it should be borne in mind that the unit-module principle of structuring and expanding sectors and transport-warehousing flows, the organizational-economic control systems and a potential for gradually putting capacities on-stream are prerequisites for introducing GAP if a plant is to be renovated or retooled without a full shutdown.

In radio and electronics production, particular attention is paid to planning standard structures for machine shops, since machining labor intensiveness comprises a third of all product manufacturing labor intensiveness. Such structures are comprised of an adjustable unitized machine tool and a NPC machine tool or processing center which are unified by a common control system and transport-storage system. GAP modules are designed for maximum equipment universality, to ensure greater machine tool adjustment flexibility and minimal readjustment of the part being machined. They can process a specific group of parts, which is why enterprises are faced with the important task of grouping and standardizing the parts being processed, so that flow-line methods can be used.

The drawing [page following] shows a consolidated diagram of GAP organizational interaction for a machine shop with ASU to one of the enterprises and with an automated design bureau (AKB) and department of the chief technologist (OGT).

Consolidated Enterprise Organizational Structure Diagram



Key:

1. OGT
2. Enterprise ASU
Subsystems: ASU TPP, ASU OPP, ASU MTO, ASU "Kadry"
3. AKB: ARM-K, ARM-T
4. Local VT
5. SAP "Tekhtran"
6. STO
7. Module control system
8. Module technological equipment
9. NChPU
10. SAU GAP linking device
11. Robot
12. Robot control system
13. Chip collection system
14. SAU GAP
15. Finished product control system
16. NChPU ATS
17. Automated transport-warehousing system
18. Tool supply system
19. Automated turret robot GAP
20. Frame-making robot GAP
21. Plating GAP
22. Machine shop GAP

The development of comprehensively mechanized and automated production facilities based on standard flexible automated technological modules requires a comprehensive approach to production organization and management.

We have now created the objective prerequisites for widely disseminating fundamentally new organizational target-program management structures.

The preferred sphere of use of target-program management structures is robots to develop and introduce into production high-technology items, to replace existing technology with more progressive, more productive, low-waste technology, to retool and renovate enterprises and improve product quality, to design and introduce automated technological-process control systems for all types of production and automated enterprise control systems.

At the same time, we must raise the level of tool, mechanical-repair, energy and transport-warehousing service systems, labor organization, product quality control, labor stimulation and rate-setting, and personnel training and skill improvement.

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AUTOMATED LINES AND AGGREGATED MACHINING SYSTEMS

UDC 621.9.077

TOOL CHANGING SYSTEMS FOR NC MACHINING CENTERS REVIEWED

Kiev *TEKHNOLOGIYA I ORGANIZATSIYA PROIZVODSTVA* in Russian No 2, Feb 84
pp 25-27

[Article by Yu. I. Kuznetsov, candidate of technical sciences, "Devices for Automatic Change of Tools in NC Machine Tools"]

[Text] The use of devices for the automatic change of tools (ASI) is one of the premises for machining intermediate products with unmanned technology. ASI devices make it possible to reduce considerably (to 10-5 seconds and less) the time spent on changing tools in multipurpose NC machining centers and eliminate worker errors when changing tools.

The tool magazines of ASI devices are subdivided into two basic groups:

The magazines of the first group have actuators that sense the cutting force. They are made in the form of turret heads with stationary tools (on lathes) or multitool spindle heads (on milling and drilling machine tools). The tools are mounted in magazines and are not changed during the machining time of the entire lot of intermediate products.

The most widely used in NC lathes are the 8-position or duplex 4-position turret heads. The first are more universal since, when using duplex 4-position heads, it is difficult to use the tool to machine internal surfaces (one of the heads interferes).

The TNS42 and the TNS60 models of lathes made by the "Traub" Firm (FRG) have a 12-position head with a sloped axis mounted on the carriage which makes possible the simultaneous use of the tools mounted on the tailstock.

In recent years, multipurpose lathes have been using 8-position turret heads with stationary tools and 4-position ones with rotary spindle heads that provide full machining on one machine tool (turning, drilling and milling) of parts of the flange, bushing and sleeve types.

Magazines of the second group are intended only to store the tools. They are subdivided into disk, chain and drum types. The largest number of tools can be mounted in drum and chain magazines. The magazines can be placed on the spindle stock, as well as on the column or on the bed of the machine tool.

In the first case, the tool can be changed in any position of the spindle stock; however, due to the effect of large weights of the tools on their inertia, machining accuracy is reduced. In the second case, the tool can be changed only in a certain position. Also available are ASI designs with a chain magazine, installed on the machine tool bed, mounted on the machine tool bed, with a synchronized movement of the spindle stock and magazine with the result that the tools can be changed in any position of the spindle stock.

Magazines, mounted outside the machine tool on a separate foundation (tool modules) which provides for their large capacity, convenient servicing, possibility of observing the operation of the module and protecting the tool from chips, dust and emulsion, as well as eliminating the effect of the weight of the tool set on machining accuracy. Such tool modules are made by the SIP and DIXI firms (Switzerland).

The module of the SIP Firm with model 4000 machining centers consists of a chain magazine with a capacity of 40 tools, an automatic operator that transports the tools from the magazine to the waiting position for their change, and a double-grip automatic tool operator. Model 410 modules are made by the DIXI Firm for machining centers in three type-sizes with magazine capacities of 50, 72 and 144 tools and double-grip automatic operators. The module of the first type has a chain magazine and a double-grip automatic operator, while modules of the second and third types have multiple-row drum magazines consisting of three or six coaxially mounted drums with a capacity of 24 tools each. One drum, that has coded sockets, is designed for tools with diameters of up to 320 mm, while the rest -- for coding tools with diameters of up to 160 mm.

The tool module made by the "Kelch" Firm (FRG) consists of a drum magazine with a vertical rotation axis and a double-grip automatic operator which may be mounted on the bed of (or beside) machining centers with a vertical spindle, for example, on machine tools made by the "Kolb" and "Wanderer" Firms (FRG).

Tool modules of model MIV50.01 and MIV50.21 (NRB) consist of a screw magazine and a two-arm automatic operator mounted on one base. The magazine sockets are located along the helical line. For the automatic operator to bring the required tool into position for gripping, the magazine is rotated with respect to the vertical axis and is lifted or lowered simultaneously.

The use of tool modules that can be mounted on various machine tools makes it possible to series manufacture such modules which reduces their cost considerably.

To increase the number of tools needed to machine housing parts in one setting, several magazines are used on one machine tool. Thus, when using dual-disk magazines, one of them is located in front of the machine tool and its tools are used for machining, while the second is located in the rear of the machine tool which makes it convenient to replace tools during machine tool operation. Magazine systems with an automatic device are also used to replace them. In this case, the change of tools in the magazine is done outside the machine tool during its operation. For example, the "Pegard" Firm (FRG) makes

machining centers with an automatic device for changing the disk magazine with a capacity of 30 tools. This operation is automatic and is done by an automatic operator. To replace a dull tool automatically when using unmanned technology on machining centers, a rotary dual-disk magazine with a capacity of 24 tools is used. Similar tools are installed in each magazine. After machining a given number of intermediate products the magazine is replaced automatically.

Three types of ASI devices are used; for changing the spindle unit; for changing the tools in the machine tool spindle; and the combination type.

Devices for changing the spindle unit may be made in the form of turret heads or drum magazines of spindle sleeves, connected alternately to the drive. Lately, the simplest ASI devices are being used in the spindle of the machine tool at small and average size machining centers that do not have automatic operators. Thus, the machining center with a horizontal model ng-h65 spindle made by the "Huller-Hille" Firm (FRG) is equipped with two disk magazines with capacities of two 20 tools, mounted to the right and left of the machine tool spindle. The magazines are designed not only for storing tools, but also for changing them in the spindle of the machine tool (the magazines may be replaced).

Combination ASI devices have a turret head, a tool magazine and an automatic operator that changes the tool in the upper spindle of the turret head during the machining time of the intermediate product by the tool mounted in the lower spindle. The remaining positions of the turret head are intended for stiffer spindles in which tools are mounted for doing heavy work (milling, countersinking).

On heavy NC plano-miller machine tools with vertical spindles, besides magazines with tools and automatic operators with interchangeable angular (milling or drilling) adapters with horizontal or sloped spindles that make it possible to machine intermediate products on five sides with one setting. In this case, tools mounted in the vertical spindle of the machine tool machine the upper surface, while the angular adapters machine the side surfaces of the intermediate product.

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ROBOTICS

INDUSTRIAL ROBOTS PENETRATE MOLDAVIAN MACHINE TOOL PLANTS

Kishinev SOVETSKAYA MOLDAVIYA in Russian 10 Apr 84 p 2

[Article by I. Shkorupeyev, deputy chairman of the Moldavian Republic Council of the Scientific and Technical Society: "The Robot in the Shop"]

[Text] It seems only quite recently that the appearance of the robot in the republic's enterprises was practically extraordinary. But today over 350 various types of automatic manipulators with programmed control are already operating in various sectors of industry.

The use of industrial robots has proven to be especially sound practice in sections with hazardous, heavy or monotonous work conditions. They immediately increase labor productivity and free work hands. Equally important is the fact that industrial robots and manipulators open new possibilities for industry's transition to a qualitatively new level of automation--development of versatile automated production facilities with minimal human participation.

In the socialist commitments of the workers of Moldavia for 1984, as is known, it calls for continuing development of fully mechanized and automated shops and plants and installing more than 1,000 units of highly productive equipment, including 70 industrial robots.

This is no simple task. It is a complex scientific and technical problem, affecting all aspects of enterprises' activities, including social; therefore, it must be resolved fully.

At the first stage, for rendering methodological assistance to the republic's enterprises the Moldavian Republic Council of Scientific and Technical Societies established a scientific method council and three consultation posts for robot technology: in Kishinev at the House of Technology, in Bel'tsy at the Production Association imeni V. I. Lenin and in Tirasopol at the Foundry Machine Plant imeni S. M. Kirov. The method council has developed a comprehensive program for propaganda and promoting the introduction of robot technology, which includes conducting conferences, seminars, competitions and reviews, and organizing continuously operating exhibits of new items in this field. In addition, at the people's university of the House of Technology a

"Robotization and Robot Technology" department has been organized where 35 people are being taught on a 40-hour curriculum.

However, today even this is not enough. As a survey conducted by the method council of the scientific and technical society (NTO) showed, the level of introduction of robot technology at the enterprises of Moldavia does not yet meet the current requirements. Suffice it to say that of the 65 plants, factories and associations examined, only 12 have planned goals for this indicator, and even these 12 are of union subordination. Specifically, those not having them are enterprises of light, food, construction and construction materials industries, domestic services, trade and the Selkhoztekhnika State Committee. The managers of them allude to the weakness of the technical base and the lack of material funds and specialists with the necessary qualifications.

There is some reason in these arguments. But the reasons pointed out do not give the right to abandon initiative, pending the beginning of industrial robot production for every sector on a centralized basis. On the contrary, in our opinion it is necessary to combine the efforts not only of the enterprises but also of the ministries and departments in order to conduct preparatory work on a large scale. Today, for example, many enterprises are requesting our scientific method council to offer specific assistance in developing technical documentation for robotization of existing production lines where manual labor is still predominant. But our public method council is not a planning and technological firm and cannot contract to do this work.

Doesn't this fact indicate that the time has come to organize a self-supporting republic intersectorial center on robot technology with experimental production for performing such work? Such robot technology centers are already operating in Leningrad, Novosibirsk and Nikolayev oblasts and in the Baltic republics. These centers conduct specific research at the enterprises and give recommendations for introducing robot technology, regardless of their departmental subordination, design highly efficient automated equipment and means for technical equipment of robotized complexes, and help in the development, manufacture and introduction of robots for enterprises of light industry, food industry and other non-machine building sectors.

Also, in our view, it is advisable to establish under the MSSR Gosplan a public republic coordination council for problems of robot technology. Specific experience in this matter has also been amassed in the country. These councils provide methodological guidance in operation of robot technology, review draft plans of scientific research work in this area and the course of their implementation, and propaganda of the achievements of robotization of production processes.

Needless to say, effective development of this fundamentally new direction of technical progress is impossible without organizing extensive training of a specific profile of qualified personnel. Enterprises are needing a broad profile of electronics engineers, programmers and repairmen in ever increasing numbers. The Kishinev Polytechnical Institute, having organized instruction

of engineers for the specialty "Automatic Manipulators and Industrial Robotized Complexes", can make a considerable contribution in resolving this problem. One would think that specialists should be more thoroughly familiarized with the fundamentals of robot technology at the Republic Intersectorial Institute for Improvement of Qualifications.

Finally, the time has also come to think about who will repair the robot technology at the enterprises. For the present, individual specialists are taking care of this. But there clearly will not be enough of them when its introduction takes on a massive nature. Therefore, it is extremely necessary even today without delay to begin training robot technology repairmen in the republic vocational and technical education system.

Thus, it is necessary to implement a whole complex of measures republic-wide in order to accelerate as much as possible the robotization of labor-intensive processes at the republic's enterprises and gain the necessary effect from it. The appropriate subdivisions of the gosplan, ministries and departments as well as the republic's Academy of Sciences are called upon to participate most actively in developing and realizing these measures.

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